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MASS TRANSFER IN THE POROUS ELECTRODES OF A LEAD-ACID BATTERY DURING ITS DISCHARGE

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At present, the study of diffusion-controlled processes with volume and heterogeneous chemical reactions plays an important role in various systems, in particular engineering ones, which include electric current sources. Based on familiar equations, this work considers ion exchange processes in the porous spaces of the electrodes of a lead-acid battery during its discharge. Allowance is made for electrochemical processes between the solid electrodes and the electrolyte that fills the porous space. As distinct from the majority of works, allowance is also made for the two-dimensionality of the process, which is due to the geometry of the apparatus and its physical characteristics. An important feature of the work is that in the open zone between the electrodes, the mass transfer is assumed to be convective, whose intensity is much higher than that of the diffusive one in the pores of the electrodes. This allows one to ignore, at least as a first approximation, the resistance of the central zone of the electric cell in the process of ion transfer. This, as one might say, limiting scheme, greatly simplifies the problem of charge transfer through the central zone of the electrochemical cell. It is shown that the electrical conductivity of the solid part of the electrodes plays an important role in the distribution of potentials both in the electrodes themselves and in the porous space. Due to the high electrical conductivity, the negative electrode relative to the positive one operates practically in a one-dimensional mode. It should also be noted that the additional resistance of the separator has a noticeable effect on the operation of the positive electrode, which manifests itself at relatively high currents, when the lack of the charging component becomes noticeable. Another important aspect of the calculation is the determination of the distribution of poorly soluble and poorly conductive lead sulfate ($PbSO_4$), which affects the mass transfer process to a large extent, up to the termination of the discharge. It is shown that at relatively high currents, the formation of the passivating product is concentrated on the outer sides of the electrodes.

Keywords: lead-acid battery, anode, cathode, system of equations, porosity, potential, diffusion transfer

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